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METHOD FOR MANUFACTURING MOLDED ELEMENTS OF ALKALI SILICATE
[VERFAHREN ZUR HERSTELLUNG VON FORMKÖRPERN AUS ALKALISILIKAT]

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DESCRIPTION /1*

Producing heat-resistant and porous molded elements in that an alkali silicate solution, possibly with fiber or other reinforcement substances, is evaporated until it is dry enough so that it contains 10 to 35% water is known. The product obtained is then crushed, placed in a mold and immediately heated in it to high temperatures. This method yields molded elements with very low weight per unit volume, but it is relatively complicated because of its procedure.

It has now been found that molded elements with possibly porous structure can be obtained in a simple manner if alkali silicate particles with a water content of 5 to 45%, and preferably 15 to 30%, can be formed at 100 to 400°C in a known way by extruders or injection molding machines and the molded elements produced in this way are possibly subjected to a further heat treatment above 200°C and advantageously at 200 to 600°C.

For manufacturing the alkali silicate particles to be used according to the invention, it is possible to start with alkali silicate solutions in any concentration, e.g. silicate solution from which the water is evaporated to the respectively desired residual content at temperatures that advantageously lie under 140°C according to known methods, e.g. by heating in molds or on rollers or also by spraying by nozzle into a heated gas flow. Upon evaporation of the water in the molds it is advantageous, in order to prevent adherence of the solidified products on the vessel walls, to give them a hydrophobic surface by coating or spraying with hydrophobic substances, e.g. wax. For the same purpose, the vessel walls

* Numbers in the margin indicate pagination in the foreign text.

can also be clad with plastic or rubber film. The water is evaporated to a residual content of 5 to 45%. The water content can be varied as desired within these limits. For duration of drying and storage capacity, it is especially advantageous to adjust the water content to 15 to 30%. The mass contained in the molds for drying is then crushed to individual particles according to known crushing methods, e.g. milling, hammer bar mills, cutting or breaking. In order to prevent individual particles from caking together during longer-term storage or even with higher water content, the particles can also be powdered with parting agents, e.g. talcum, diatomaceous earth, etc. The grain size of the alkali silicate particles to be used depends on the dimensions of the machine to be used for forming and is advantageously selected in such a way that the most favorable density ratio of the heating zone of this machine is ensured. However on the other hand, especially with piston machines, particles that are too fine, e.g. with a diameter below 0.2 mm, should not be placed in the machine since otherwise there is a danger that these can become deposited between cylinder wall and piston and can thus block the machine.

In the manufacturing of the alkali silicate molded elements, in general the extruders or injection molding machines known for processing plastic masses can generally be used with no problems. Both piston and worm injection molding machines can be used; the same is true of extruders. As known with the processing of thermoplastics, the worm injection molding machines also offer the advantage that larger molded elements can be produced while processing alkali silicates.

With the use of a worm machine, the processing runs without problems

especially if the ratio of worm length to worm diameter is between 3:1 and 15:1. In addition worms that are not cut too flat should be used, whereby the rib height will be between 10 and 40% of the worm diameter. In general, worms without compression can be used. For worms with compression, the compression ratio will advantageously be less than /2 3:1. In order to avoid the alkali silicate from already foaming in the worm, the worm temperature is kept below a value of about 140°C by using cooling if necessary. In contrast the temperatures that are set at the nozzle and/or at the machine head can be varied within wide limits, depending on the desired weight per unit volume of the molded element to be produced. As usual, the cross section of the nozzle is tuned to the size of the molded element to be manufactured and to the yield capacity of the machine. For piston machines, analogous considerations apply with regard to the nozzle dimensions.

The temperatures to be set in the machine ends during manufacturing of molded elements can be varied within wide limits. During the processing of alkali silicate particles containing water, for example with a water content of 40%, advantageously lower temperatures can be used, for example in the range from 100 to 120°C, while in particles with low water content, e.g. a water content from 20 to 25%, advantageously temperatures from 170 to 210°C are selected. Besides that, the choice of the suitable forming temperature depends on the desired structure of the molded element to be manufactured. While at higher temperatures, e.g. over 200°C, molded elements that already have a porous structure and lower density are obtained, forming at temperatures below 200°C yield elements that are

largely clear as glass and compact. The structure of the molded elements produced according to the operating method of the invention, apart from the temperature, also depends on the pressures present in the processing machine. This means, for example, at a given temperature compact, glassy molded elements with a higher density will be obtained at higher pressures and porous elements with correspondingly lower density at low pressures.

If porous molded elements, especially those with large dimensions, will be manufactured, advantageously pressure and temperature conditions are maintained in which compact molded elements are obtained. These are then foamed by a heat treatment of temperatures above 200°C, and advantageously from 200 to 600°. The upper limit of the temperatures that can be used for the heat treatment is the sintering point of the alkali silicate used in the particular case, which among other things depends on the ratio of alkali oxide to silicon dioxide. Advantageously, in this case the procedure proceeds in that gradually increasing temperatures are used, whereby especially with large molded elements the danger of crack formation due to non-uniform heating is decreased. It is especially advantageous to perforate the molded elements before perforating; in this case porous molded elements are obtained that are especially mechanically stable and free of tensions. In this case, the size of the perforations can be dimensioned in such a way that after the foaming process a molded element with a uniform structure is obtained as a result of expansion of the material. Because of the height of temperature used during the foaming process, on one hand the resistance of the molded elements to the influence of water is influenced, and on the other, the porosity.

For example, this means that at temperatures of about 200°C porous molded elements are obtained, which are still partially water soluble and have a weight per unit volume of about 300 to 500 g/l, while in contrast after a heat treatment up to temperatures of 500°C, elements that are practically insoluble are obtained with a weight per unit volume below 300 g/l, e.g. 150 to 200 g/l. The heat treatment named can be carried out discontinuously or continuously, i.e. the continuously operating extruders or discontinuously operating injection molded machines can be arranged downstream with no problems. For manufacturing elements with special dimensional stability, it is recommended that the heat treatment be carried out in molds that cannot be sealed gas-tight.

The treatment of profiles coming continuously from an extruder is advantageously carried out so that these are guided through zones with increasing temperature between endless, moved and heat-resistant belts, whereby the line speed is naturally oriented to the outlet speed of the profiles from the extruder. In order to take into account the volume increase caused by foaming of the element, the belts are advantageously arranged in such a way that in the direction of increasing temperature they diverge according to the volume enlargement of the treated elements. Instead of between belts, the heat treatment can be carried out on plates moved between rollers.

To lend an especially designed surface, the foam molded elements manufactured in this way are subjected to another mechanical treatment, e.g. milling, polishing, cutting with saws, etc.

A chemical treatment, e.g. with calcium chloride, sulfuric acid,

etc. can give the molded elements special characteristics with respect to their watertightness.

By addition of fillers to the alkali silicate particles, special effects for the molded elements can be achieved. The mechanical stability of the molded element is significantly increased by incorporation of organic and/or inorganic fiber materials. To lower the weight per unit volume of the molded elements, porous and crushed particles can also be added, e.g. of pumice, cork powder, etc. Colored molded elements are obtained if pigments are added to the alkali silicate particles, preferably those of an inorganic nature or even colored salt solutions.

Depending on the machines and molds used, molded elements of all different designs can be manufactured. Using extruders, manufacturing can be carried out in a continuous manner of profiles, tubes, panels, half-shells, etc. Using the injection molding method, molded elements of practically any desired design can be manufactured. The weights per unit volume of the molded elements that can be achieved can be varied within wide limits. For example, molded elements can already be made with a weight per unit volume of 30 g/l, but on the other hand also those with a weight per unit volume of 2000 g/l.

The molded elements manufactured according to the invention are /3
preferably suited to be insulators against heat, cold or noise because of their non-combustibility and poor heat conductivity and especially because of their fine-pored structure in foamed state. Because of their high heat resistance, the insulating properties against heat and sound continue to exist even at high temperatures.

Example 1

Sodium silicate particles with a diameter of 1 to 3 mm and a water content of 28% are placed in an extruder that has a worm with a length of 250 mm, a diameter of 40 mm and a rib height of 5 mm. The worm is used as a conveying worm and has no compression. It carries out 50 to 60 revolutions per minute. The extruder head with a ring nozzle of 30 mm diameter is heated to 170 to 190°C.

A glass-like round rod with a density of 2000 g/l and high mechanical strength is obtained, the surface of which has a 1 mm thick porous coating.

When the round rod is heated to 400°C, whereby the temperature is increased by 50°C every 15 minutes, a cylindrical, mechanically stable and porous molded element is obtained with a diameter of 55 to 60 mm and a weight per unit volume of 230 g/l.

The mechanical stability of the porous molded element that is obtained by heating to 400°C can be even further increased if before heating, holes of about 40 mm having a diameter of about 2 mm are drilled in the round rod. After heat treatment at 400°C, the holes are foamed shut.

Example 2

Alkali silicate particles with a diameter of 0.5 to 4 mm and a water content of 15% are placed in an extruder with the dimensions given in Example 1 and a nozzle that is 100 mm wide and 5 mm high. The extruder head is held at temperatures from 200 to 220°C. The profile that comes out, which is still warm, is then pressed smooth between two rotating rollers.

During heating of the profile to 450°C, with foaming a volume increase

of the profile occurs. The weight per unit volume of the plate is 190 g/l.

The profile escaping from the nozzle is sawed into 20 cm long plates, four such plates are placed in a pipe half shell mold with 1.5 l content and then heated to 350°C for 1 hour. A pipe half shell that is porous and mechanically very stable is obtained that has a weight per unit volume of about 300 g/l.

Example 3

A cylindrical chamber with a diameter of 50 mm and a length of 60 mm is connected to an extruder with the dimensions given in Example 1. At the end of this chamber there is a ring nozzle with a diameter of 20 mm. With the use of this worm, sodium silicate particles with a water content of 30% are slowly pushed into the chamber that is heated to about 220 to 250°C.

A cylindrical foam molded elements with a weight per unit volume of about 150 g/l comes out of the nozzle.

Example 4

On an extruder with the worm dimensions specified in Example 1, on the head a nozzle is connected that is 100 mm wide, 100 mm long and has an initial height of 5 mm that increases continuously to 15 mm. The nozzle end is heated to 400°C, the start of the nozzle is heated to 200°C. The temperature in the worm is held at 100°C by cooling. The worm carried out approx. 15 revolutions/min.

Sodium silicate particles with a water content of 25% are placed in the machine.

The molded element obtained in this way has a weight per unit volume of 250 g/l.

Example 5

Sodium silicate particles with a water content of 24% are placed in an extruder, the worm of which has a length of 450 mm, a diameter of 30 mm, an initial rib height of 4 mm and a compression of 2.2:1. The worm carried out 35 to 40 revolutions/min. A round nozzle with a diameter of 10 mm and a ring-shaped chamber of 1 mm thick is arranged at the head of the extruder; this nozzle is heated to temperatures of 250 to 270°C.

A tube-like molded element already having a porous structure with a weight per unit of volume of 500 g/l, an inner diameter of 10 mm and a wall thickness of 3 mm comes from the nozzle.

Example 6

Potassium silicate particles with a water content of 20% and a grain size from 1 to 4 mm are poured into an injection molding machine with a cylinder diameter of 50 mm. The cylinder is heated to 170 to 190°C. A tool in the form of a square rod having a length of 100 mm and a base surface of 15 x 10 mm is connected to the cylinder by way of a nozzle with 4 mm diameter, into which the potassium silicate is pressed. The inner walls of the tool are powdered with talcum as a mold separating agent. The molded element obtained in this way is very hard, glassy and resistant to bending and has a weight per unit volume of 2000 g/l.

Claims:

1. Method for manufacturing possible porous molded elements of alkali silicate, characterized in that alkali silicate particles with a water content of 5 to 45%, and preferably 15 to 30%, at 100 to 400°C in a known way are formed using extruders or injection molding machines and the molded elements produced in this way are possibly subjected to another heat treatment above 200°C, and advantageously at 200 to 600°C.

2. Method according to Claim 1, characterized in that the heat treatment of the molded element is carried out with gradual increase of the temperature.

3. Method according to Claims 1 and 2, characterized in that the /4 molded element is perforated before the further heat treatment.

4. Method according to Claims 1 to 3, characterized in that fillers are added to the alkali silicates before forming.

5. Method according to Claims 1 to 4, characterized in that pigments and/or colored salt solutions are added to the alkali silicates before forming.

6. Method according to Claims 1 to 4, characterized in that before forming, fiber materials of an inorganic and/or organic nature are added to the alkali silicates.